What is claimed is:

1. A bipolar article having an arbitrary form factor, the article comprising:

(a) a bipolar structure having an anode, a cathode, and an electrolyte in contact with and separating the anode and cathode, wherein the anode and cathode are interpenetrating;

(b) a cathode current collector that is in electronic communication with the cathode; and

(c) an anode current collector that is in electronic communication with the anode,

wherein the bipolar article has a desired arbitrary configuration.

2. The article of claim 1, wherein the anode and cathode are self-assembling networks of particles disposed in the electrolyte, and wherein the cathode current collector is attractive to the cathode network and repulsive to the anode network, and the anode current collector is attractive to the anode network and repulsive to the cathode network.

3. The article of claim 2, wherein one or both of the anode and cathode current collectors comprises a coating providing a repulsive force between the current collector and the opposite anode or cathode network.

4. The article of claim 3, wherein the coating includes one or more of a conductive oxide, polythiophene, polyanaline, poly(o-methoxyaniline) (POMA), poly(3-octylthiophene) (POTh), poly(3,4-ethylene dioxythiophene) (PEDT), poly(3,4 ethylene dioxythiophene)-polystyrene sulfonate (PEDT-PSS), poly(vinylidene fluoride) (PVDF), poly(ethylene oxide) (PEO), polytetrafluoroethylene (PTFE), and derivatives thereof.

5. The article of claim 1, wherein the anode, electrolyte, and cathode are sequentially deposited.

6. A device comprising the bipolar article of claim 1.

7. The device of claim 6, wherein the arbitrary configuration of the bipolar article is

conformal with at least one surface of the device.

8. The device of claim 6, wherein the device has a cavity, and wherein the arbitrary configuration of the bipolar article is space-filling within the cavity.

9. The device of claim 6, wherein the device is a cellular telephone, laptop computer, personal digital assistant, or toy.

10. The article of claim 1, wherein the bipolar article is a battery.

11. A bipolar article having an arbitrary form factor, the article comprising:

(a) a bipolar structure having an anode, a cathode, and an electrolyte in contact with and separating the anode and cathode;

(b) a cathode current collector that is in electronic communication with the cathode; and

(c) an anode current collector that is in electronic communication with the anode,

wherein the bipolar article has an arbitrary configuration that has a thickness that varies across the length or width of the article.

12. The article of claim 11, wherein the anode and cathode are interpenetrating.

13. The article of claim 12, wherein the anode and cathode are self-assembling networks of particles disposed in the electrolyte, and wherein the cathode current collector is attractive to the cathode network and repulsive to the anode network, and the anode current collector is attractive to the anode network and repulsive to the cathode network.

14. The article of claim 13, wherein one or both of the anode and cathode current collectors comprises a coating providing a repulsive force between the current collector and the opposite anode or cathode network.

15. The article of claim 14, wherein the coating includes one or more of a conductive oxide, polythiophene, polyanaline, poly(o-methoxyaniline) (POMA), poly(3-octylthiophene) (POTh), poly(3,4-ethylene dioxythiophene) (PEDT), poly(3,4 ethylene

dioxythiophene)-polystyrene sulfonate (PEDT-PSS), poly(vinylidene fluoride) (PVDF), poly(ethylene oxide) (PEO), polytetrafluoroethylene (PTFE), and derivatives thereof.

16. The article of claim 11, wherein the anode, electrolyte, and cathode are sequentially deposited.

17. A device comprising the bipolar article of claim 11.

18. The device of claim 17, wherein the arbitrary configuration of the bipolar article is conformal with at least one surface of the device.

19. The device of claim 17, wherein the device has a cavity, and wherein the arbitrary configuration of the bipolar article is space-filling within the cavity.

20. The device of claim 17, wherein the device is a cellular telephone, laptop computer, personal digital assistant, or toy.

21. The article of claim 11, wherein the bipolar article is a battery.

22. A battery powered device comprising:

(a) an interpenetrating electrode battery;

(b) a housing; and

(c) a mechanism powered by the battery,

wherein the battery is integrated in the housing.

23. The device of claim 22, wherein the battery is formed in a cavity in the housing.

24. The device of claim 22, wherein the battery has interpenetrating electrodes that are formed from a self-organizing bipolar material.

25. The device of claim 22, wherein the battery has interpenetrating electrodes that are sequentially deposited.

26. The device of claim 22, wherein the device is a cellular telephone, laptop computer, personal digital assistant, or toy.

27. A bipolar article comprising:

(a) first and second interpenetrating electrodes;

(b) a plurality of first interpenetrating current collector features wired in parallel and in electronic communication with the first interpenetrating electrode; and

(c) a second current collector in electronic communication with the second interpenetrating electrode,

wherein the plurality of first interpenetrating current collector features is distributed through the thickness of the article.

28. The article of claim 27, wherein the interpenetrating current collector features comprise prongs at least partially embedded in the first electrode.

29. The article of claim 27, wherein the interpenetrating current collector features comprise a mesh.

30. The article of claim 29, wherein the mesh defines a plurality of openings, each opening having a width greater than about 200 μm.

31. The article of claim 27, wherein the interpenetrating current collector features are distributed through the thickness of the article with a spacing between adjacent current collector features that is selected to reduce the electronic transport path length within the bipolar article to provide increased power density of the article.

32. The article of claim 27, wherein the interpenetrating current collector features are distributed through the thickness of the article with a spacing between adjacent current collector features that is selected to increase the volume percentage of electrode material in the article to provide increased energy density of the article.

33. The article of claim 27, wherein the second current collector includes interpenetrating features distributed throughout the thickness of the article.

34. The article of claim 33, wherein the interpenetrating features comprise prongs.

35. The article of claim 27, wherein at least one of the interpenetrating electrodes is a

porous electrode.

36. The article of claim 27, wherein the interpenetrating electrodes are formed from a self-organizing bipolar material.

37. The article of claim 27, wherein the interpenetrating electrodes are sequentially deposited.

38. The article of claim 27, having a power density greater than about 300 W/kg.

39. A bipolar article comprising:

(a) a bipolar structure having an anode, a cathode, and an electrolyte in contact with and separating the anode and the cathode, wherein at least one of the anode and the cathode includes a lithium-containing electroactive material;

(b) a cathode current collector that is in electronic communication with the cathode; and

(c) an anode current collector that is in electronic communication with the anode,

wherein at least one of the anode and cathode current collectors includes one or more features projecting into the bipolar structure containing the anode and the cathode,

and wherein the minimum distance between adjacent current collectors is at least about 500 μm.

40. The article of claim 39, wherein the minimum distance between adjacent current collectors is at least about 750 μm.

41. The article of claim 39, wherein the minimum distance between adjacent current collectors is at least about 1000 μm.

42. The article of claim 39, wherein both the anode and cathode current collectors include projecting features.

43. The article of claim 42, wherein the projecting features are prongs.

44. The article of claim 39, wherein the projecting feature is a mesh.

45. The article of claim 44, wherein the mesh layer defines a plurality of openings, each opening having a width greater than about 200 μm.

46. The article of claim 44, including multiple layered meshes electrically wired in parallel.

47. The article of claim 39, wherein the anode includes one or more materials selected from the group consisting of carbon, amorphous carbon, graphite, mesocarbon microbeads, Li, LiAl, $Li_9Al_4$, $Li_3Al$, Zn, LiZn, Ag, LiAg, $Li_{10}Ag_3$, B, $Li_5B_4$, $Li_7B_6$, Ge, Si, $Li_{12}Si_7$, $Li_{21}Si_8$, $Li_{13}Si_4$, $Li_{21}Si_5$, Sn, $Li_5Sn_2$, $Li_{13}Sn_5$, $Li_7Sn_2$, $Li_{22}Sn_5$, Sb, $Li_2Sb$, $Li_3Sb$, Bi, LiBi, and $Li_3Bi$, $SnO_2$, SnO, MnO, $Mn_2O_3$, $MnO_2$, $Mn_3O_4$, CoO, NiO, FeO, $LiFe_2O_4$, $TiO_2$, $LiTi_2O_4$, and glass.

48. The article of claim 39, wherein the cathode includes one or more materials selected from the group consisting of $LiCoO_2$, $LiCoO_2$ doped with Mg, $LiNiO_2$, $LiMn_2O_4$, $LiMnO_2$, $LiMnO_2$ doped with Al, doped and undoped $LiFePO_4$, $LiMnPO_4$, $LixV_6O_{13}$, $Li_2Fe_2(SO_4)_3$, $V_2O_5$, $V_6O_{11}$, and $SnO_2$.

49. The article of claim 39, wherein the anode and cathode are self-assembling networks of particles disposed in the electrolyte, and wherein the cathode current collector is attractive to the cathode network and repulsive to the anode network, and the anode current collector is attractive to the anode network and repulsive to the cathode network.

50. The article of claim 49, wherein one or both of the anode and cathode current collectors comprises a coating providing a repulsive force between the current collector and its respective anode or cathode network.

51. The article of claim 50, wherein the coating includes one or more of a conductive oxide, polythiophene, polyanaline, poly(o-methoxyaniline) (POMA), poly(3-octylthiophene) (POTh), poly(3,4-ethylene dioxythiophene) (PEDT), poly(3,4 ethylene dioxythiophene)-polystyrene sulfonate (PEDT-PSS), poly(vinylidene fluoride) (PVDF), poly(ethylene oxide) (PEO), polytetrafluoroethylene (PTFE), and derivatives thereof.

52. The article of claim 39, wherein the electrolyte is selected from the group consisting of LiI, LiF, LiCl, $Li_2O$-$B_2O_3$-$Bi_2O_3$ compounds, $Li_2O$-$B_2O_3$-$P_2O_5$ compounds, $Li_2O$-$B_2O_3$-PbO compounds, and sols and gels of oxides and hydroxides of Ti, Zr, Pb, and Bi.

53. The article of claim 39, wherein the electrolyte is selected from the group consisting of poly(ethylene oxide) (PEO), poly(styrene) (PS), poly(acrylonitrile) (PAN), poly(vinylidene fluoride) (PVDF), diiodomethane (DIM), 1,3-diiodopropane, N,N-dimethylformamide (DMF), dimethylpropylene urea (DMPU), ethylene carbonate (EC), diethylene carbonate (DEC), dimethyl carbonate (DMC), propylene carbonate (PC), and block copolymer lithium electrolytes, the material being doped with a lithium salt to provide lithium ionic conductivity.

54. The article of claim 39, wherein at least one of the anode and cathode is a porous electrode.

55. The article of claim 39, wherein the anode, electrolyte, and cathode are sequentially deposited.

56. The article of claim 39, having a power density greater than about 300 W/kg.

57. A bipolar article comprising:

(a) a porous first electrode;

(b) at least one first current collector, wherein at least a portion of the first current collector is embedded within and in electronic communication with the porous first electrode;

(c) an electronically insulating, ionically conductive material coating the pore structure of the porous first electrode;

(d) within the pores of the coated porous first electrode, a second electrode having opposite polarity to the porous first electrode; and

(e) a second current collector in electronic communication with the second electrode.

58. A multi-layered lithium ion battery having an energy density greater than about

212 Wh/kg.

59. A method of making a bipolar article having an arbitrary form factor, the method comprising:

(a) providing a first current collector in a mold having a configuration corresponding to the desired arbitrary form factor;

(b) depositing on the first current collector a first electrode material, an electrolyte material, and a second electrode material, wherein at least one of the electrode materials is configured to have one or more features projecting into the electrolyte material and the other electrode material; and

(c) providing a second current collector on the first electrode, electrolyte, and second electrode materials.

60. The method of claim 59, wherein the first electrode, electrolyte, and second electrode materials are deposited sequentially.

61. The method of claim 59, wherein the first and second electrode and electrolyte materials are deposited by coating, printing, or injection molding.

62. The method of claim 59, further comprising stamping or embossing one of the current collectors or electrode materials to provide a surface having an arbitrary configuration.

63. The method of claim 59, wherein the electrolyte comprises an ionically permeable separator.

64. The method of claim 59, wherein the mold is an electronic device or device housing.

65. The method of claim 59, wherein the first and second electrode and electrolyte materials are included in a self-organizing bipolar material.

66. The method of claim 65, further comprising curing the self-organizing bipolar material.

67. The method of claim 66, wherein curing the self-organizing bipolar material forms cathode and anode networks, and wherein one of the first and second current collectors is attractive to the cathode network and repulsive to the anode network, and the other of the first and second current collectors is attractive to the anode network and repulsive to the cathode network.

68. A bipolar article having an arbitrary form factor made by the method of claim 59.

69. A method of making a bipolar article having an arbitrary form factor including a thickness that varies across the length or width of the article, the method comprising:

(a) providing a first current collector in a mold having a configuration corresponding to the desired arbitrary form factor;

(b) depositing on the first current collector a first electrode material, an electrolyte material, and a second electrode material; and

(c) providing a second current collector on the first electrode material, electrolyte material, and second electrode material,

whereby a bipolar article is formed with an arbitrary configuration that has a thickness that varies across the length or width of the article.

70. The method of claim 69, wherein the first electrode, electrolyte, and second electrode materials are deposited sequentially.

71. The method of claim 69, wherein the anode, cathode, and electrolyte materials are deposited by coating, printing, or injection molding.

72. The method of claim 69, wherein the electrolyte comprises an ionically permeable separator.

73. The method of claim 69, wherein the mold is an electronic device or device housing.

74. The method of claim 69, wherein at least one of the electrode materials is configured to have one or more features projecting into the electrolyte material and the other electrode material.

75. A bipolar article having an arbitrary form factor made by the method of claim 69.

76. A method of making a layered interpenetrating bipolar article, the method comprising:

(a) providing a first current collector;

(b) depositing on the first current collector an electrode region comprising an interpenetrating network including an anode material, an electrolyte material, and a cathode material;

(c) providing a second current collector on the electrode region;

(d) repeating steps (a) through (c) at least once; and

(e) electrically connecting the first current collectors with each other and with one of the anode or cathode materials, and electrically connecting the second current collectors with each other and with the other of the anode or cathode materials.

77. The method of claim 76, wherein steps (a) through (c) are repeated between about two times and about ten times.

78. The method of claim 76, wherein the anode, electrolyte, and cathode materials are deposited sequentially.

79. The method of claim 76, wherein the anode, electrolyte, and cathode materials are provided in a self-organizing bipolar material.

80. An interpenetrating bipolar article made by the method of claim 76.

81. A method of making an interpenetrating bipolar article, the method comprising:

(a) providing a first current collector having at least one prong;

(b) depositing on the first current collector an electrode region comprising an interpenetrating network including an anode material, an electrolyte material, and a cathode material, whereby the prong of the first current collector extends into one of the anode and cathode materials; and

(c) providing a second current collector on the electrode region.

82. The method of claim 81, wherein the anode material, the electrolyte material, and the cathode material are deposited sequentially.

83. The method of claim 81, wherein the anode, cathode, and electrolyte materials are provided in a self-organizing bipolar material.

84. An interpenetrating bipolar article made by the method of claim 81.

85. A method of making an interpenetrating bipolar article, the method comprising:

(a) assembling a mold containing a first current collector;

(b) suspending a plurality of second current collector mesh layers above the first current collector in the mold;

(c) introducing a self-organizing bipolar material to the mold, thereby covering the first and second current collectors with the self-organizing bipolar material; and

(d) curing the self-organizing bipolar material to form interpenetrating anode and cathode networks separated by an intervening electrolyte, wherein one of the anode and cathode networks is attractive to the first current collector and repulsive to the second current collector, and the other of the anode and cathode networks is attractive to the second current collector and repulsive to the first current collector.

86. The method of claim 85, further comprising providing a spacing between adjacent second current collector mesh layers of at least about 500 μm.

87. The method of claim 86, wherein the spacing provided between adjacent second current collector mesh layers is least about 750 μm.

88. The method of claim 86, wherein the spacing provided between adjacent second current collector mesh layers is least about 1000 μm.

89. The method of claim 85, wherein each second current collector mesh layer defines a plurality of openings, each opening having a width greater than about 200 μm.

90. An interpenetrating bipolar article made by the method of claim 85.